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A Holistic Approach to Energy Medicine Trial Data: Exploratory Analyses

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Abstract

The study's objectives were to evaluate the relationships between the subjective pain scores and nerve conduction velocity (NCV), demographic/predictor variables, and objective outcomes from data collected in an energy medicine study on participants with hand and wrist pain. Subjective and objective measures were collected before a 30-minute energy medicine session, immediately after the session, and three weeks later. The primary outcomes were subjective pain ratings and the affected wrist's NCV. Secondary outcomes included subjective, physiological, and environment-related measures. The relationships between these measures were evaluated with linear mixed-effect and cumulative link models and redundancy analyses. Slower NCV was associated with practitioner gender being male and lower participant age. Improved pain was associated with income being $75k to under $150K and the personality trait of openness. Subjective variables, electrocardiography (ECG) measures, geocosmic, and water variables explained 9% (geocosmic) up to 29% (subjective/demographic) of the pain and NCV scores. All differences in variables or change scores explained 9% of the baseline-post-session pain and NCV scores and 54% of the variation in the baseline to 3-week pain and NCV scores. Multiple significant positive and negative correlations between variables with each other and with pain and NCV were found. This study's results support the notion that practitioner and participant gender, participant age, income, health status, and the personality trait of openness play some role in energy medicine sessions and pain relief. ECG and geocosmic variables explain variability in pain and NCV change. Additional studies exploring the nuances of these relationships are warranted.

Keywords: Subtle Energy; Biofield; Energy Medicine; Hand And Wrist Pain; Carpal Tunnel Pain

Abbreviations: NCV: Nerve Conduction Velocity; SE: Standard Error; DF: Degrees of Freedom; RDA: Redundancy Analysis; Bse: Baseline Pain

Introduction

Energy medicine is a field of complementary and integrative medicine. The National Center for Complementary and Integrative Health calls energy medicine, energy healing therapy and defines it as, "A technique that involves channeling healing energy through the hands of a practitioner into the client's body to restore a normal energy balance and, therefore, health. Energy healing therapy has been used to treat a wide variety of ailments and health problems, and it is often used with other alternative and conventional medical treatments" [1].

The belief in a biofield and subtle energy has been recorded in ancient cultures for millennia. The characteristics of a subtle energy system in the Vedic tradition and Chinese medicine are examples of models for health and healing constructed from millennia of religious and spiritual belief and thoughtful observation [2,3]. A recent expansion of interest and research in energy medicine has increased our understanding of biofields and energy medicine [2, 4-6].

Commonly used energy medicine therapies like Reiki, Therapeutic Touch, Emotional Freedom Techniques, and Thought Field Therapy have growing evidence for their positive effects [2, 3]. Enough studies in energy medicine have now been conducted to perform meta-analyses, which reveal energy medicine's positive results for cancer, chronic pain, anxiety, depression, and trauma [2, 4-6].

Energy medicine appears to be particularly helpful for pain. Chronic pain is, unfortunately, a common and costly public health issue. Approximately 6.5 million people in the U.S. experienced chronic pain in one survey, with 8% reporting their pain was substantially restricting their life activities for six months or more [7]. Chronic pain often leads to other issues such as fatigue, sleep disturbance, and mood changes, compounding functional disability [8,9]. Chronic pain is also expensive as one survey reported $61 billion lost annually from worker productivity [10,11].

One common type of pain is hand and wrist pain that often comes from carpal tunnel syndrome [12,13]. The carpal tunnel is a narrow passageway of ligament and bones at the hand's base that encircles the median nerve. Carpal tunnel syndrome typically occurs when the median nerve is compressed as it travels through this passageway, causing pain. It also causes numbness and tingling in the hand and arm. While some studies evaluated energy medicine for pain from various etiologies [4-6, 14], only one randomized controlled trial evaluated energy medicine for carpal tunnel syndrome with surprisingly positive results [15].

To elucidate energy medicine's effects and mechanism, a pilot clinical trial was conducted with energy medicine practitioners who performed one 30-minute session for each participant with hand and wrist pain [16]. Multiple subjective demographics, psychological pain, pain-related measures, and objective physiological (electrocardiography and nerve conduction velocity) and environmental outcomes were collected during the study. The study found significant improvements in subjective pain, pain-related, and psychological outcomes immediately after the session and three-weeks later. Heart rate variability changes suggested increased parasympathetic activation and a potential mechanistic pathway for clinical improvement. Various exploratory environmental measures also changed significantly compared to controls [17-19]. However, evaluating these measures individually may not provide a complete picture of what is happening during an energy medicine session. Perhaps comprehensive statistical models incorporating all the measures could offer more information about energy medicine's mechanism and its effects.

This general line of research aims to discover energy medicine's mechanism for eliciting clinical improvements. This analyses' objectives were to evaluate the relationships between 1) subjective pain scores and nerve conduction velocity and the demographic/predictor variables, and 2) the relationships between the objective outcome variables with each other and with subjective pain and nerve conduction velocity scores. As this was an exploratory study, there were no hypotheses generated for these research questions. We present the following article in accordance with the MDAR reporting checklist.

Materials and Methods

In an uncontrolled, within-participant study design, 17 energy medicine practitioners provided one 30-minute session to 190 participants with hand and wrist pain. Measures were evaluated before the session (baseline), immediately after the session (post-session), and three weeks later (3-wk). All study activities were approved and overseen by the Institutional Review Board at the Institute of Noetic Sciences (IORG#0003743). Detailed methods for the parent study are reported elsewhere [16]. A summary of relevant methods is reported here.

Adult participants with chronic hand or wrist pain were recruited from the San Francisco bay area. Participants needed to be over 18 years of age experiencing carpal tunnel pain (persistent numbness, tingling, or pain in the hand, fingers, or thumb); no eligibility cut-off point for pain was set. Exclusion criteria included pregnancy and the use of pacemakers. Participants were given a $200 gift card after completing all study activities. Three-hundred and seventy people initially responded to the study advertisement. Of those, 190 were eligible and received a 30-minute energy medicine session; 184 came to the three-week follow-up.

Seventeen practitioners administered the sessions. Most combined multiple modalities throughout the treatment session, the primary modality used by each was: 1) Shaktis, 2) Rosalyn Bruyere method, 3) Reiki, 4) Barbara Brennan method, 5) clairvoyant healing, 6) Bengston Energy Healing method, 7) Healing Touch, 8) Peruvian shamanic healing, 9) psychokinetic healing, 10) channeling healing energy of ascended masters, 11) calling in Holy Spirit, 12) quantum healing, 13) Xponential Intelligence, 14) Pranic Healing, 15) Quantum-Touch, 16) Krysantha Healing, and 17) psychic manipulation of auras. Some practitioners (10) used light, stationary touch throughout the sessions and the others used exclusively non-physical means. Data analyses considered all of the practitioners collectively and did not compare results obtained between individual practitioners.

Measures

Subjective and objective outcomes and potential predictors were included in the analyses.

Subjective Outcomes

The Numeric Pain Rating Scale (NPRS) is a segmented numeric version of the visual analog scale where participants select a whole number (0 = "No pain" to 10 = "Worst possible pain") that best reflects the intensity of their pain. This scale was assessed before their in-person visit and at their three-week follow-up [20].

The Modified Brief Pain Inventory was adapted for use in this study. Participants rated their pain/numbness for their worst discomfort in the last week, least discomfort in the last week, and current discomfort. They also rated pain interference with regular work, relationships, and enjoyment of life [21].

The Sleep Quality Scale (SQS) measured the quality of participants' sleep the night before, rated from 0-10 (with 0 representing the best sleep) [22]. Positive and negative affective

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well-being was measured with six dichotomous indicators (happiness, enjoyment, smiling/laughter, stress, worry, sadness), asking participants whether they had experienced an emotional state for much of the day yesterday. Responses for positive and negative emotions were averaged for two scores ranging from 0-1 [23].

The Arizona Integrative Outcomes Scale (AIOS) is a one-item, visual analog self-rating scale that evaluates the overall subjective sense of well-being over the past 24 hours. Participants were instructed to consider their physical, mental, emotional, social, and spiritual condition and rate it on a scale of 0-100 with larger values indicating greater well-being Bell et al. [24].

Objective Outcomes

Objective outcomes were participant-related and environment-related. The participant-related outcomes were collected from the participants' body: nerve conduction velocity (NCV) and electrocardiography data (ECG).

Nerve Conduction Velocity (NCV). The median sensory nerve's conduction on the affected wrist was measured using an XLTEK Neuromax 1002 nerve conduction stimulator (Excel-Tech Ltd., Oakville, Canada). A small electric stimulus was applied at the wrist, and the signal was recorded from the index finger. Conduction velocity was determined by the ratio of the distance measured divided by the onset latency.

Electrocardiography Data (ECG). ECG data were collected simultaneously from the participant and practitioner with a Biopac M150 System with Universal Interface (Biopac Systems, Inc., Goleta, CA) in one data file to ensure time-matched data with two EMG100C units. Two small electrode sticker pads (from Biopac, Inc.) were placed below the clavicles on the participants' right and left sides. The practitioner was asked to be still while administering energy medicine for the first and last six minutes of the session to ensure clean ECG collection for these measures.

Heart Rate Variability Measures. Raw ECG data were exported to Kubios HRV Premium 3.4.1 (Kubios OY, Kuopio, FINLAND). Parasympathetic, sympathetic, and stress indices, time-domain measures (mean RR interval, standard deviation of normal RR intervals, mean heart rate, root mean square of the successive differences), auto-regressive spectral analysis (very low frequency, low frequency, high frequency, total power, low frequency to high-frequency ratio) and non-linear measures (Poincaré plot for the standard deviation perpendicular (SD1) and along to the line-of-identity (SD2) and short term (DFAα1) and long-term (DFAα2) detrended fluctuation analysis), and ECG derived respiration were calculated.

Coherence. The coherence ratio of participant ECG signal of the first and last six minutes of the session was also calculated. Physiological coherence, used extensively by HearthMath, Inc. (Boulder Creek, CA), is reflected in more ordered and sine wave-like HRV patterns at a frequency of around 0.1 Hz (10 seconds rhythm). A coherent rhythm can be defined as a relatively harmonic (sinewave-like) signal with a very narrow, high-amplitude peak in the LF region of the HRV power spectrum, with no major peaks in the VLF or HF regions. Coherence was assessed by identifying the maximum peak in the 0.04–0.26 Hz range of the HRV power spectrum, calculating the integral in a window 0.03 Hz wide centered on the highest peak in that region, and then calculating the total power of the entire spectrum. The coherence ratio is formulated as [PeakPower/(TotalPower-PeakPower)] [25].

Average Heart Rate Synchrony. Heart rate synchrony measured the relationships between the participant's ECG signal and that of the practitioner for the first six-minute and the last six-minute segments. The first and last six minutes of the session were used because ECG data is sensitive to movement. The practitioners were still during these parts of the session so that clean ECG could be obtained. Three measures were computed, correlation, phase coherence, and coherence synchronization. Correlation synchronization measures the correlation of the signal amplitudes. Phase coherence synchronization measures the alignment of the phase of the signals. Coherence synchronization is a mixture of the two previous measures. Specifically, the Kubios RR time series obtained for each channel (participant: channel 1 and practitioner channel 2) were exported to text files and reimported by Matlab custom scripts [26]. The time series contained the exact latencies of each ECG peak. The ECG alignment between the practitioner and participant was performed by linear interpolation of the RR time series to a common time frame with a one-second increment (*interp1* function of Matlab 2019a).

The channels were then bandpass filtered in both directions (to avoid phase distortion) using a five-order Butterworth filter for each frequency of interest (broadband, referring to all frequencies and no filtering; LF which is low-frequency HRV from 0.04 to 0.15 Hz and HF which is high-frequency HRV from 0.15 to 0.40 Hz; butter and filtfilt functions of Matlab 2019a). A Hilbert decomposition was then applied to the band-passed signal (*hilbert* function of Matlab 2019a) to obtain instantaneous amplitude and phase of the signal at 1 Hz resolution. Amplitude correlation is the standard Pearson correlation coefficient between the practitioner's Hilbert signal amplitude and the time-synchronized signal amplitude of the participant. Coherence is the average of the product of the Hilbert spectral decomposition of the participant with the time-synchronized complex conjugate of the Hilbert signal for the practitioner data. Phase coherence is the same as coherence, although the amplitude information is first removed from all spectral estimates by normalizing all spectral estimates - thereby providing the average phase difference between the two signals. Correlation, coherence, and phase coherence were calculated for the broadband signal, low-frequency, and high-frequency bands.

Time Series Heart Rate Synchrony. Time-varying synchrony analysis (i.e., observing how the synchrony between the

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practitioner and the participant changed over time) was used to evaluate synchrony change for the first six minutes of the energy medicine session. The synchrony measures described above were computed over sliding non-overlapping windows of 30 seconds interspaced by 30 seconds over a single six-minute window. The slope of each synchrony measure's norm was then used as an indicator of change during the first six minutes of the energy medicine session.

Environment-Related Outcomes

These outcome measures reflected the covariation of the energy medicine sessions, water in the environment, and the environment in general.

Quantum noise generator (QNG). A quantum noise generator data were continuously collected from the device's placement inside the electromagnetically shielded chamber, where the energy medicine sessions were conducted throughout the four-month active phase of the parent study. Data included in this analysis are the values from the 24th minute of the session, representing an average maximal peak of the QNG [17].

Water infrared absorbance. The infrared absorbance of the water samples on the practitioner and participant exposed to the energy medicine treatments was measured by attenuated total reflection Fourier transform infrared (ATR-FTIR) spectroscopy. Values from wavenumber 3200 were included as this wavenumber showed significant differences between session and control conditions [18].

Potential Predictors

The following measures were collected as subjective and objective potential predictors of changes in pain scores and NCV.

Practitioner information: Gender and whether they used touch during the session.

Participant demographics: Age, gender, education, relationship status, race, income

The Big Five Inventory-10 is a 10-item scale that evaluates the Big-5 personality constructs of extraversion, openness, conscientiousness, neuroticism, and agreeableness [27].

The Noetic Belief and Experience Scale is a 20-item scale where participants rate their level of belief and experience in noetic constructs, e.g., affecting the physical world with the mind and mind-to-mind communication, on a sliding scale from 0-100 with 100 representing greater belief and more experience [28].

The Credibility and Expectancy Scale measured the participants' level of belief in, or credibility, regarding energy medicine's efficacy and their expectations that energy medicine would work for them [29], on a Likert scale ranging from 1-9, with higher scores representing higher credibility and expectancy. Credibility and expectancy are essential to measure in interventions where placebo may play an important role in mind-body medicine [30].

Geocosmic. Lunar illumination, solar wind speed, interplanetary magnetic field (IMF), solar wind, proton energies (10, 30, 60 mega-electron-volts), proton fluence (1, 10, and 100 mega-electron-volts), electron fluence (2, 8, and 100 mega-electron-volts), solar radio flux, number of visible sunspots (SSN), area of the sun covered by sunspots (SS Area), geomagnetic field, geomagnetic field globalAp, local barometric pressure, humidity, wind speed, rain, maximum and minimum temperature, and time of day of the energy medicine session. Values for 18 variables were extracted from databases maintained by the Jet Propulsion Labs of the National Aerospace and Space Administration (https://ssd.jpl.nasa.gov/horizons.cgi), and by the National Oceanic and Atmospheric Administration's National Centers for Environmental Information, including the solar terrestrial database (https://www.ngdc.noaa.gov/stp/GEOMAG/kp_ap.html), spaceweather database (https://www.ngdc.noaa.gov/stp/solar/solarwind.html), and the local climatological database (https://www.ncdc.noaa.gov/cdo-web/datatools/lcd).

Statistical Analyses

These analyses' goals were two-fold: 1) to evaluate the relationship between demographic/predictor variables and subjective pain and NCV values, and 2) to evaluate the relationships between all the measures and in relation to the subjective pain and NCV values.

All analyses were completed using the statistical programming language R [13].

Linear Mixed-Effects Model: A linear mixed-effect model was fitted to the log of NCV (NCV) using restricted maximum likelihood estimation (REML) in the *nlme* package in R [31]. The model was fitted with a random intercept for the participant, allowing for three repeated measures (baseline, post-session, 3-wk) per client. The explanatory variables included demographic and psychological variables. Assumptions of residual normality and homoscedasticity at all model levels were examined via diagnostic plots. Post-hoc differences in time points (baseline, post-session, 3-wk) were examined using the R package *emmeans* [32].

Cumulative Link Mixed Model: A cumulative link mixed model was fitted to subjective pain in the ordinal package in R [33]. A cumulative link mixed model assumes the response variable is an ordered factor (ordinal) variable, whereas a linear mixed-effects model assumes the response variable is continuous. The model was fitted with a random intercept for the participant, allowing for three repeated measures (baseline, post-session, 3-wk) per participant. The explanatory variables included demographic and psychological variables. Post-hoc differences in time points (baseline, post-session, 3-wk) were examined using

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the R package *emmeans* [32].

Redundancy analysis (RDA) (Constrained Ordination): RDA was performed using the R package *vegan* [34]. RDA combines regression and Principal Component Analysis (PCA) by performing a multivariate (multiresponse) multiple linear regression and then subsequently a PCA on the fitted values matrix. This generates linear combinations of the independent variables that explain multivariate response variation. The axes model the multivariate response variation, permitting a global hypothesis test of the lack of a linear relationship between the multivariate response and independent variables [35,36]. A series of RDAs were performed to evaluate hypotheses about specific multivariate relationships, including an RDA examining the relationship between NCV and subjective pain at specific time points (baseline, post-session, 3-wk) and/or the change scores for these variables and (1) subjective variables measured at the baseline and 3-week time points and differences between these time points, (2) ECG variables measured at the baseline and post-session time points and differences between these time points, (3) geocosmic variables measured at the baseline and 3-week time points and differences between these time points, and (4) water and infrared absorbance variables measured at the baseline and post-session time points as well as the differences between these time points.

In addition, two RDAs were conducted examining only the changes in pain score and NCV and combined explanatory variables. Specifically, the first RDA examined the relationship between baseline - post-session changes in subjective pain and NCV and changes in geocosmic variables, water variables, and three summary ECG variables (PNS index, SNS index, and Stress Index). The second RDA examined the relationship between baseline - 3-week session changes in subjective pain and NCV and changes in geocosmic variables, water variables, and three summary ECG variables (PNS index, SNS index, and Stress Index). For these latter two RDAs, the explanatory variables' differences were not taken over consistent time points, as in the previous RDAs. Some explanatory variables, e.g., geocosmic, were taken as differences between the baseline and three-week time periods, while others, e.g., ECG, were taken as differences between the baseline and post-session time periods. Hence, these RDAs use explanatory variables that are taken over two relevant time periods and examine the relationships among them.

The results were summarized as triplots (Scaling 2, lc scores). R_2 and adjusted R_2 values were calculated to summarize the relationship between the explanatory and response variables. A global test of the RDA result using 5000 permutations was computed for each RDA to assess the significance of the linear relationship between the explanatory and response variables.

Results

Full reporting on participant demographics are presented in parent study paper [16]. One-hundred and ninety participants received an energy medicine session (55.0 ± 13.9 years old, 84.3% female).

Potential Predictors

NCV. The results of linear mixed-effects models examining the change in log NCV with potential subjective predictors are summarized in (Table 1). There was no significant change over baseline, post-session, or 3-week values for NCV in the presence of demographic and health-related variables (p > 0.05), but practitioner gender (p = 0.037) and age were associated with NCV (p = 0.037). Practitioner gender being male was associated with lower log NCV (i.e., slower NCV) than practitioner gender being female. Lower participant age was associated with lower log NCV (Table 1).

Subjective Pain Symptoms. The cumulative link mixed model results examining the change in pain symptoms with time, and demographic and health-related variables are summarized in (Table 2). There were significant differences between baseline, post-session, and 3-week subjective pain scores in the presence of potential subjective predictor variables (p < 0.00005). Practitioner touch (p = 0.02), participant gender being male (p = 0.01), fair general health (p = 0.01), and good general health (p = 0.04) were associated with increased pain scores (i.e., more pain), at fixed levels of the remaining predictor variables. Income being $75k to under $150K compared to the base level of $150K or greater ($p$ = 0.02) and the personality trait of openness (p = 0.02) were associated with decreased pain scores (i.e., less pain), at fixed levels of the remaining predictor variables (Table 2).

Redundancy Analysis (RDA)

RDA results are summarized via R_2, adjusted R_2, and ANOVA results in (Table 3). The data supported linear relationships between the response and explanatory variables at individual time points and via change scores for subjective variables. For geocosmic and ECG variables, the data only supported linear relationships between change scores (Table 3).

Subjective variables at the baseline explained about 14%, 29%, and 21% of the unbiased variation in the baseline, 3-week follow-up, and baseline to 3-week follow-up change pain and NCV scores. The data supported a linear relationship between these variables (S1, S2, S3 in (Table 3); p <0.002).

ECG variables at the baseline and post-session did not explain variation in baseline pain, and NCV scores and the data did not support a linear relationship. Change in ECG variables from baseline to post-session explained 17% of the unbiased variation in the change in pain and NCV scores, and the data supported a linear relationship (E3 in (Table 3); p =0.0002).

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Table 1: NCV linear mixed-effects model results. The response variable was log NCV. Random effects: the standard deviation of the intercept was 0.060, and the standard deviation of the residual was 0.23.

Measure	Value	SE	DF	*t*-value	*p*-value
(Intercept)	4.022	0.254	141	15.837	<0.00005
Post-session	0.001	0.036	141	0.021	0.983
3-week follow-up	-0.012	0.036	141	-0.331	0.741
Practitioner Gender	-0.077	0.036	85	-2.117	0.037*
Practitioner Touch	0.021	0.036	85	0.57	0.57
Age	-0.003	0.001	141	-2.107	0.037*
Gender (Male)	-0.0008	0.051	85	-0.154	0.878
Education	0.005	0.008	85	0.691	0.491
Not in Relationship	0.062	0.043	85	1.458	0.148
Race					
Asian or Asian American	-0.071	0.149	85	-0.478	0.634
Black or African American	0.053	0.216	85	0.244	0.808
Hispanic or Latino	0.052	0.146	85	0.358	0.722
White or Caucasian	0.023	0.134	85	0.175	0.862
Income					
under $75K	-0.047	0.06	85	-0.784	0.435
$75K to under $150K	-0.002	0.057	85	-0.04	0.968
General Health					
Fair	-0.005	0.083	85	-0.057	0.954
Good	0.002	0.076	85	0.027	0.978
Very Good	0.029	0.074	85	0.384	0.702
Personality					
Extraversion	-0.007	0.019	85	-0.358	0.721
Agreeableness	-0.001	0.022	85	-0.05	0.96
Conscientiousness	-0.009	0.024	85	-0.38	0.705
Neuroticism	-0.006	0.021	85	-0.298	0.766
Openness	-0.034	0.022	85	-1.511	0.134
Credibility	0.002	0.017	85	0.135	0.893
Expectancy	-0.006	0.011	85	-0.551	0.583
Noetic Belief	-0.00002	0.001	141	-0.015	0.988
Noetic Experience	0.001	0.001	85	0.526	0.6

Notes: SE = standard error; DF = degrees of freedom; * = *p*-value at 0.05 or below. There was no statistically significant difference in NCV between the different time-point measures (Supplemental Data, Table 1; *p*'s > 0.94). These results are consistent with analysis conducted using a simpler

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model analyzing primary outcomes [16].

Table 2: Subjective pain cumulative link mixed model. The standard deviation of the intercept was 0.8193 (random effects).

Measure	Estimate	SE	*z*-value	*Pr*(>|*z*|)
Threshold	-3.29	2.08	-1.58	0.11
Spacing	0.56	0.03	16.14	<0.00005
Post-session	-2.58	0.28	-9.19	<0.00005
3-week follow-up	-1.42	0.25	-5.6	<0.00005
Practitioner Gender	0.02	0.28	0.06	0.95
Practitioner Touch	0.67	0.29	2.32	0.02*
Age	-0.01	0.01	-0.7	0.48
Gender (Male)	0.98	0.38	2.6	0.01*
Gender (Other)	-1.08	1.66	-0.65	0.51
Education	-0.09	0.06	-1.47	0.14
Not in Relationship	-0.23	0.34	-0.7	0.49
Race				
Asian or Asian American	2.26	1.36	1.66	0.1
Black or African American	0.54	1.79	0.3	0.76
Hispanic or Latino	1.46	1.32	1.11	0.27
White or Caucasian	1.32	1.23	1.07	0.28
Income				
under $75K	-0.45	0.46	-0.97	0.33
$75K to under $150K	-1.02	0.44	-2.32	0.02*
General Health				
Fair	1.82	0.71	2.58	0.01*
Good	1.34	0.65	2.07	0.04*
Very Good	0.81	0.63	1.28	0.2
Personality				
Extraversion	-0.01	0.16	-0.04	0.97
Agreeableness	0.07	0.18	0.38	0.7
Conscientiousness	0.32	0.18	1.72	0.08
Neuroticism	-0.06	0.17	-0.36	0.72
Openness	-0.41	0.17	-2.43	0.02*
Credibility	0.08	0.14	0.57	0.57
Expectancy	-0.13	0.09	-1.48	0.14
Noetic Belief	-0.01	0.01	-1.13	0.26
Noetic Experience	0.02	0.01	2.13	0.03

Notes: * = *p*-value at 0.05 or below. The differences between all pairwise comparisons of subjective pain measures between time points were significant (Supplemental Data, Table 2; $p < 0.0001$). These results are consistent with analysis conducted using a simpler model analyzing primary outcomes [16]. Note that since a single model was applied, there is no need to correct the statistical outcome for multiple comparisons.

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Table 3: Redundancy Analysis summary table. The global test of the RDA results is summarized with the *pseudo-F* statistic and *p*-value.

Plot	Pain & NCV Response Variables Timepoint	Explanatory Variables	R^2	Adjusted R^2	ANOVA *F*	Anova *p*-value
S1	Bse	Bse Subjective	0.21	0.16	3.64	0.0002
S2	3-wk	3-Week Subjective	0.32	0.28	7.97	0.0002
S3	Bse-3-wk Change	Bse-3-wk Subjective Change	0.24	0.2	5.93	0.0002
E1	Bse	Bse ECG	0.14	-0.07	0.67	0.96
E2	Post	Post-ECG	0.17	-0.05	0.78	0.85
E3	Bse-Post Change	Bse-Post ECG Change	0.27	0.17	2.68	0.0002
G1	Bse	Bse Geocosmic	0.11	-0.03	0.79	0.81
G2	3-wk	3-Week Geocosmic	0.13	-0.04	0.77	0.83
G3	Bse-3-wk Change	Bse-3-wk Geocosmic Change	0.18	0.09	1.92	0.0014
W1	Bse	Bse Water	0.02	-0.007	0.76	0.54
W2	Post	Post-Water	0.02	-0.009	0.71	0.56
W3	Bse-Post Change	Bse-Post Water Change	0.04	0.02	2.15	0.07
C1	Bse-Post Change	Bse-Post or 3-wk Change for All Variables	0.87	0.09	1.11	0.46
C2	Bse-3-wk Change	Bse-Post or 3-wk Change for All Variables	0.94	0.54	2.34	0.1

Notes: Response variables: Bse - Baseline pain and NCV, Post - Post-session pain and NCV, 3-wk - 3-week follow-up pain and NCV, Bse-Post - Baseline to Post-session pain and NCV change; Bse-3-wk - Baseline to 3-week follow-up pain and NCV change. Explanatory variables: Bse - Baseline, Post - Post-session, 3-wk - 3-week follow-up. An RDA summary table with ANOVA model variance, residual degrees of freedom, and residual variance is included as Supplementary Data, (Table 3).

Geocosmic variables at the baseline and post-session did not explain variation in baseline pain and NCV scores, and the data did not support a linear relationship. Change in geocosmic variables from the baseline to the 3-week follow-up explained 9% of the unbiased variation in the change in pain and NCV scores, and the data supported a linear relationship (G3 in (Table 3); *p*=0.014).

Infrared absorbance variables at all time points did not explain variation in baseline pain and NCV scores, and the data did not support linear relationships (W1, W2, W3 in (Table 3)).

All Variables. The RDA model with all variables (baseline-post-session or baseline-3-week depending on when the variable was measured) explained 9% of the baseline-post-session pain and NCV scores and 54% of the variation in the baseline to 3-week pain and NCV scores (C1, C2 in (Table 3)).

The RDA triplot for the baseline to post-session pain and NCV change, and all variables is displayed in (Figure 1). In the RDA triplots, the response variables of pain and NCV are denoted by red arrows, the explanatory variables by blue arrows, and observations by orange dots. The angles between all vectors reflect their (linear) correlation. A vector pair with a 90° are uncorrelated, a vector pair with less than a 90° are positively correlated with values closer to 0° suggesting a strong positive correlation, and vector pairs approaching 180° suggesting a strong negative correlation. Projecting an object at a right angle on a vector gives the object's approximate value along that vector. RDA triplots for baseline, post-session, and pain and NCV change scores explained by subjective, ECG, geocosmic, and water variables are available in Supplemental Data (Tables 4,5,6) (Figures 1-4).

Variables Explaining Baseline to Post-Session and Baseline to 3-Week Subjective Pain Change and NCV Change. The relationships between changes in explanatory variables (either baseline - post-session or baseline - 3-week change depending on the variable) and baseline - post-session change in response variables subjective pain and NCV are summarized in (Table 7). The relationships between changes in explanatory variables (either baseline-post or baseline 3-week) and baseline - 3-week changes in the response variables are summarized in (Table 8). Many explanatory variables are strongly correlated with one another and the response variables. Negative correlations in this situation, on the contrary, mean that as these explanatory variables' values increase, the change in the response variable decreases (Tables 7&8).

Common measure groupings were revealed between vector pairs. Sympathetic and stress indices from the ECG data were positively correlated with sunspot number, which were positively correlated with the baseline to post-session and 3-week subjective pain scores for change (i.e., an increase in pain). The parasympathetic index was positively correlated with solar wind speed, interplanetary magnetic field, proton fluence, solar radio

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flux and negatively correlated with the baseline to post-session and 3-week subjective pain scores for change (i.e., a decrease in pain).

Table 4: Post-hoc contrasts for nerve conduction velocity for the three time points using Tukey *p*-value adjustment. Tests were performed on the log scale.

Timepoint Contrast	Ratio	SE	DF	*t*-ratio	*p*-value
Pre-session to Post-session	0.999	0.036	141	-0.021	1.000
Pre-session to 3-week	1.012	0.036	141	0.331	0.941
Post-session to 3-week	1.013	0.037	141	0.347	0.936

Notes: SE = standard error; DF = degrees of freedom.

Table 5: Post-hoc contrasts of subjective pain score for the three time points using Tukey *p*-value adjustment.

Timepoint Contrast	Estimate	SE	DF	*t*-ratio	*p*-value
Pre-session to Post-session	2.58	0.28	Inf	9.19	<0.00005
Pre-session to 3-week	1.42	0.25	Inf	5.60	<0.00005
Post-session to 3-week	-1.16	0.26	Inf	-4.53	0.00002

Notes: SE = standard error; DF = degrees of freedom.

Table 6: RDA summary table.

Plot	Response Variables	Explanatory Variables	R^2	Adjusted R^2	ANOVA Model *df*	ANOVA model Variance	ANOVA residual *df*	ANOVA residual Variance	ANOVA *F*	Anova *p*-value
S1	Baseline Pain	Baseline Subjective	0.2	0.16	7	0.43	93	1.57	3.64	0.0002
S2	3-Week Pain	3-Week Subjective	0.3	0.28	7	0.63	121	1.37	7.97	0.0002
S3	Baseline - 3 Week Pain Change	Baseline - 3 Week Subjective Change	0.2	0.2	7	0.48	132	1.52	5.93	0.0002
E1	Baseline Pain	Baseline ECG	0.1	-0.07	27	0.28	109	1.72	0.67	0.96
E2	Post-Session Pain	Post-Session ECG	0.2	-0.05	27	0.33	106	1.67	0.78	0.85
E3	Baseline - Post Session Pain Change	Baseline-Post Session ECG Change	0.3	0.17	27	0.53	200	1.47	2.68	0.0002
G1	Baseline Pain	Baseline Geocosmic	0.1	-0.03	20	0.23	122	1.77	0.79	0.81
G2	3-Week Pain	3-Week Geocosmic	0.1	-0.04	20	0.25	107	1.75	0.77	0.83
G3	Baseline - 3 Week Pain Change	Baseline - 3 Week Geocosmic Change	0.2	0.09	20	0.37	171	1.63	1.92	0.0014
W1	Baseline Pain	Baseline Water	0	-0.007	2	0.04	70	1.96	0.76	0.54
W2	Post-Session Pain	Post-Session Water	0	-0.009	2	0.04	66	1.96	0.71	0.56
W3	Baseline - Post Session Pain Change	Baseline - Post Session Water Change	0	0.02	2	0.07	113	1.93	2.15	0.07

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C1	Baseline - Post Session Pain Change	Baseline - Post Session or 3-Week Change for All Variables	0.9	0.09	25	1.75	4	0.25	1.11	0.46
C2	Baseline - 3 Week Pain Change	Baseline - Post Session or 3-Week Change for All Variables	0.9	0.54	25	1.87	4	0.13	2.34	0.1

Table 7: A summary of the relationships between changes in explanatory variables (at their respective level of change, either base - post or base – 3-week, and the baseline – post-session change in response variables subjective pain and NCV).

Baseline – Post Session OR Baseline - 3 week Change	**Correlation with each other**	**Bse-Post Pain**	**Bse-Post NCV**
Solar wind (40), proton energy at 10, 20, and 30 mega-electron volts (41, 42, 43), lunar illumination (37)*, local rain (53), local maximum temperature (54), Infrared absorbance of water on practitioner (58)	Strong +	Strong +	
Sympathetic index (12), stress index (13), sunspot number (48), time of day (56), and humidity (51)	Strong +	Moderate +	
Parasympathetic index (11), solar sind speed (38), interplanetary magnetic field (39), proton fluence (46), solar radio flux (47)*, local minimum temperature (55), Infrared absorbance of participant of distilled water (57)	Strong +	Moderate to strong -	Weak to moderate +
Sunspot area (49)	N/A	Moderate +	Moderate -
Local barometric pressure (50)	N/A	Strong -	

Notes: The numbers after each measure refer to the number in the RDA triplot (Figure 1). Vector pairs approaching 0° are labeled strong positive. Vector pairs approaching 45° are labeled moderate positive. Vector pairs approaching 90° are labeled weak to uncorrelated. Vector pairs approaching 180° are labeled strong negative, and approaching 140° are labeled moderate negative. *Solar Radio Flux had the longest vector for baseline-post-session subjective pain.

Table 8: A summary of the relationships between changes in explanatory variables (at their respective level of change, either base - post or base – 3-week, and the baseline – 3-week session change in response variables subjective pain and NCV).

Baseline – Post Session OR Baseline - 3 week Change	**With each other**	**Bse-3-wk Pain**	**Bse-3-wk NCV**
Sympathetic index (12), stress index (13), infrared absorbance of participant of distilled water (57), infrared absorbance of water on practitioner (58), sunspot number (48), and local barometric pressure (50)	Strong +	Strong +	Weak to moderate +
Parasympathetic index (11), solar wind speed (38), interplanetary magnetic field (39), global geomagnetic field - Ap index (44), protonfluence (46), solar radio flux (47), local humidity (51), local rain (53), time of day for visit (56)	Moderate to Strong +	Strong -	No to weak to moderate -
Global geomagnetic field (45), local wind (52), local minimum temperature (55)	Strong +	Moderate to weak +	Strong +
Lunar illumination (37), solar wind (40), proton energies at 10 mega-electron-volts (41), sunspot area (49)	Strong +	Weak to No +	Moderate to strong -
Proton energies at 30 and 60 mega-electron-volts (42, 43) and local maximum temperature (54)	Strong +	Moderate to week +	

Notes: The numbers after each measure refer to the number in the RDA triplot.

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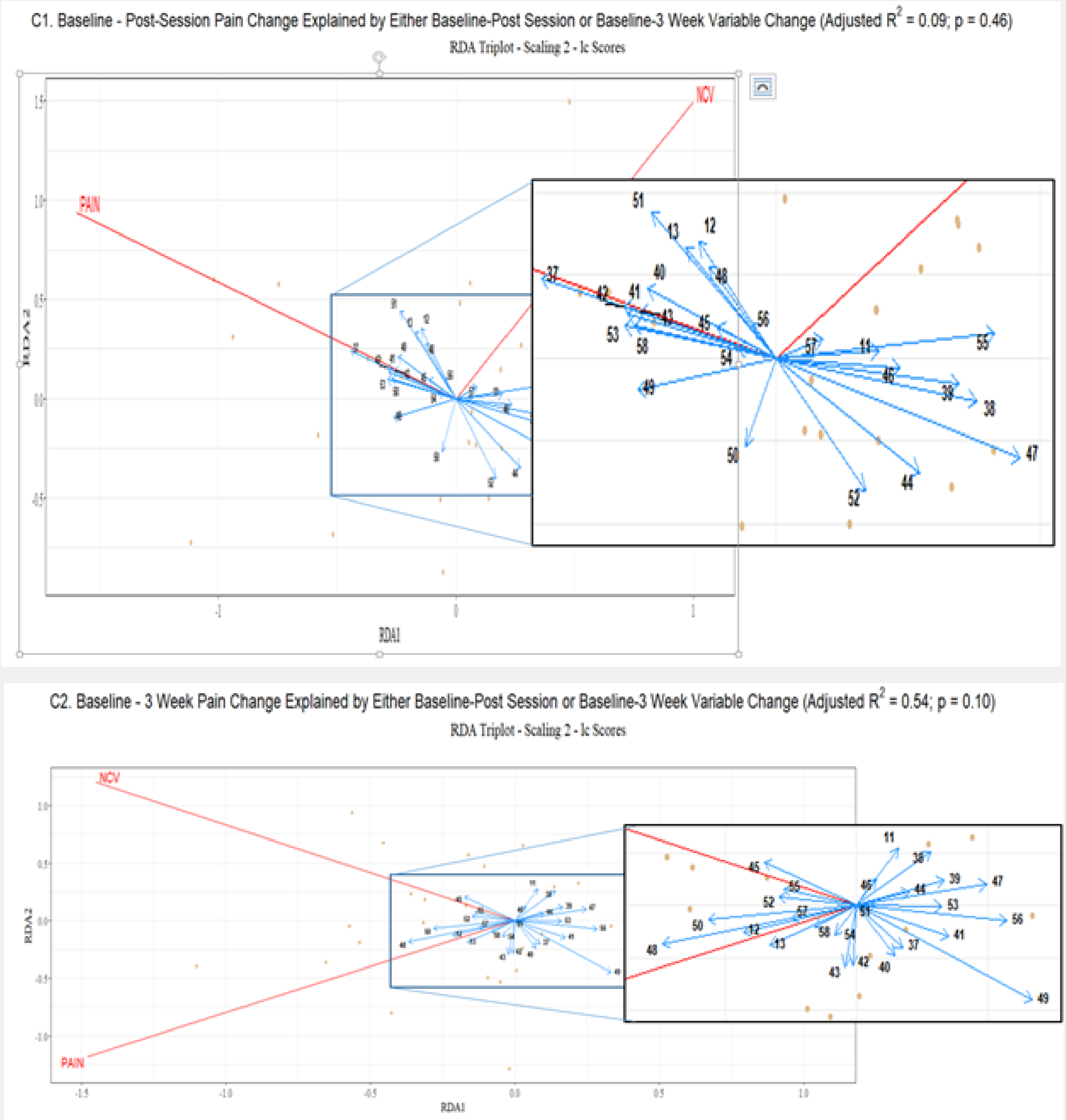

Figure 1: The RDA triplots for the baseline to post-session pain and NCV change and all variables.

Figure 1: Vector pairs approaching 0° are labeled strong positive. Vector pairs approaching 45° are labeled moderate positive. Vector pairs approaching 90° are labeled weak to uncorrelated. Vector pairs approaching 180° are labeled strong negative, and approaching 140° are labeled moderate negative.

Notes: 11 - PNS index - Parasympathetic nervous system activity compared to normal resting values, 12 - SNS index - Sympathetic nervous system activity compared to normal resting values, 13 - Stress index, , 24 - SD1 [ms] In Poincaré plot, the standard deviation perpendicular to the line-of-identity, 25 - SD2 [ms] In Poincaré plot, the standard deviation along the line-of-identity, 37 - Lunar Illumination, 38 - Solar Wind Speed, 39 - Interplanetary Magnetic Field, 40 - Solar Wind, 41 - Proton energies at 10 mega-electron-volts, 42 - Proton energies at 30 mega-electron-volts, 43 - Proton energies at 60 mega-electron-volts, 44 - Global Geomagnetic Field - Ap index, 45 - Global Geomagnetic Field, 46 - ProtonFluence1, 47 - Solar Radio Flux, 48 - SunSpot Number, 49 - SunSpot Area, 50 - Local barometric pressure, 51 - Local humidity, 52 - Local wind, 53 - Local rain, 54 - Local maximum temperature, 55 - Local minimum temperature, 56 - Time of day for visit, 57 -Infrared absorbance of participant of distilled water, 58 - Infrared absorbance of practitioner of distilled water.

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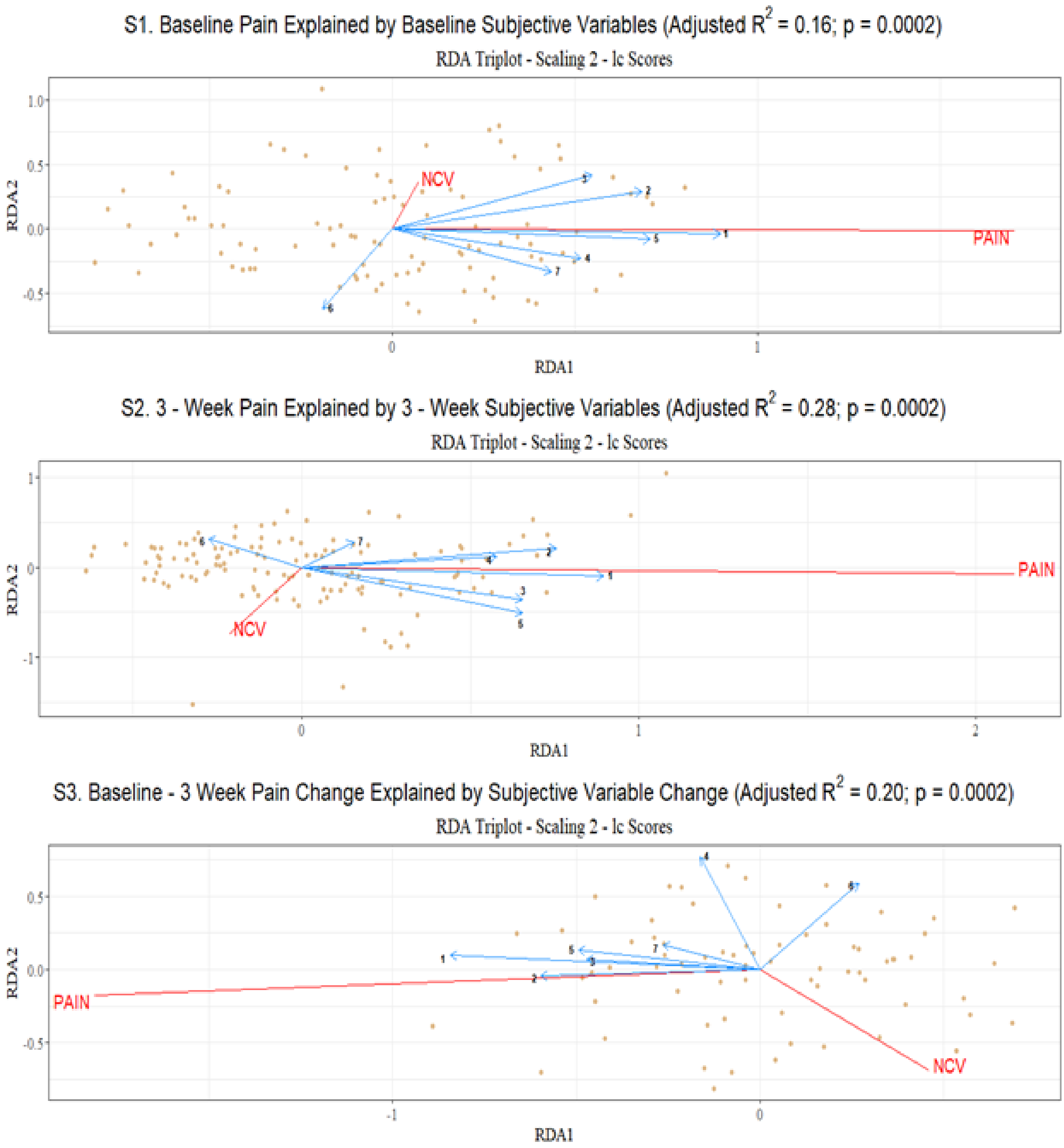

Notes: 1 - Worst pain in the last week, 2 - Least pain in the last week, 3 - Pain interference with normal work, 4 - Pain interference with relationships, 5 - Pain interference with enjoyment of life, 8 - Positive Affect, 9 - Negative Affect, PAIN - subjective pain score, NCV - nerve conduction velocity.

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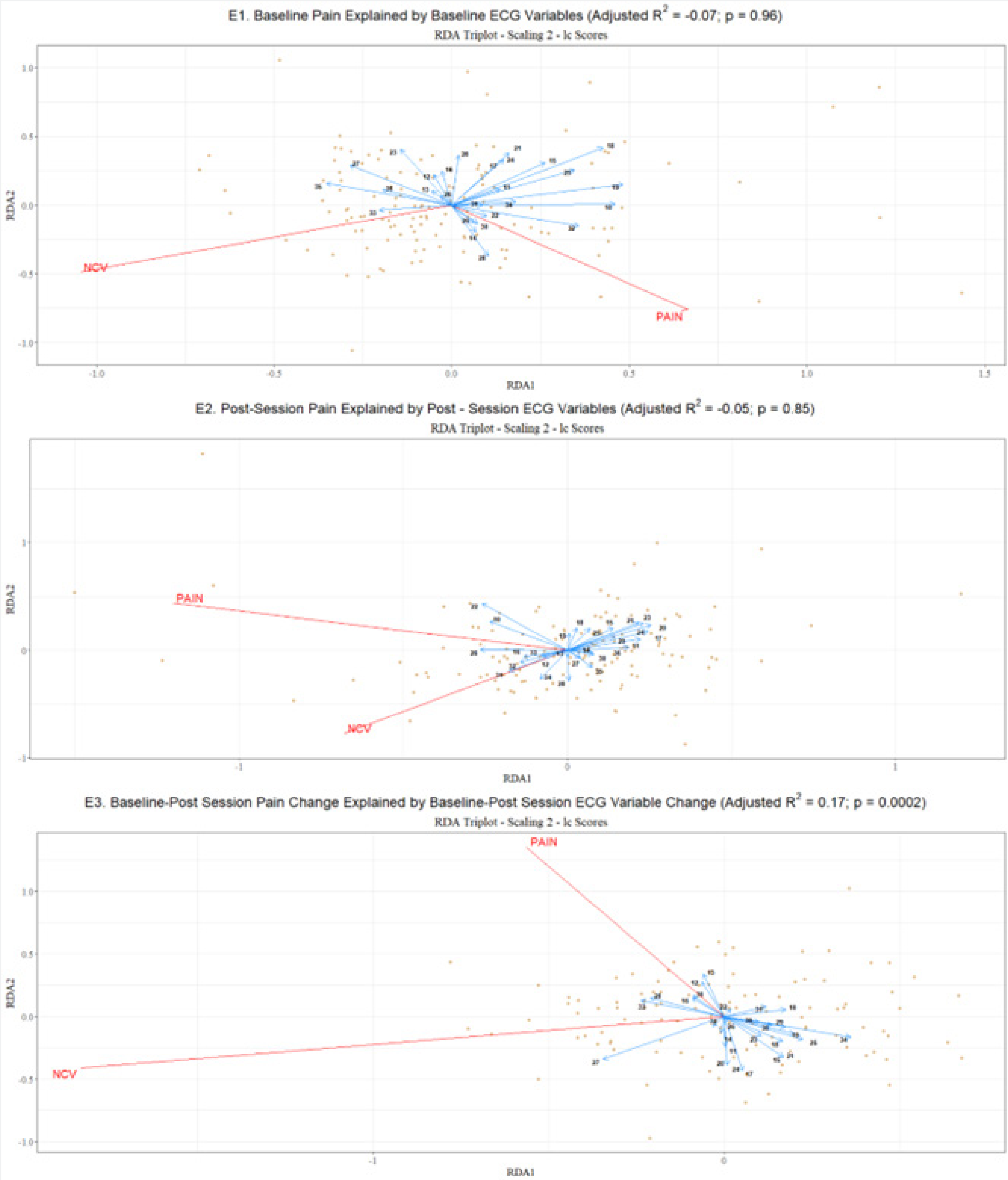

Figure 2: Notes: 10 - Coherence ratio first six minutes, 11 - PNS index - Parasympathetic nervous system activity compared to normal resting values, 12 - SNS index - Sympathetic nervous system activity compared to normal resting values, 13 - Stress index, 14 - Mean RR interval (ms), 15 - SDNN (ms) standard deviation of normal beat-to-beat interval, 16 - Mean heart rate (bpm), 17 - RMSSD [ms] Square root of the mean squared differences between successive RR intervals, 18 - Very low frequency autoregressive spectrum, 19 - Low frequency autoregressive spectrum, 20 - High frequency autoregressive spectrum, 21 - Total power autoregressive spectrum, 22 - Low frequency to high Frequency ratio, 23 - ECG derived respiration, 24 - SD1 [ms] In Poincaré plot, the standard deviation perpendicular to the line-of-identity, 25 - SD2 [ms] In Poincaré plot, the standard deviation along the line-of-identity, 26 - DFA, alpha1 - In detrended fluctuation analysis, short term fluctuation slope, 27 - DFA, alpha2 - In detrended fluctuation analysis, long term fluctuation slope, 28 - Correlation no broadband between ppt and practitioner, 29 - Coherence no broadband between ppt and practitioner, 30 - Phase coherence no broadband between ppt and practitioner, 31 - Correlation low frequency between ppt and practitioner, 32 - Coherence low frequency between ppt and practitioner, 33 - Phase coherence low frequency between ppt and practitioner, 34 - Correlation high frequency between ppt and practitioner, 35 - Coherence high frequency between ppt and practitioner, 36 - Phase coherence high frequency between ppt and practitioner.

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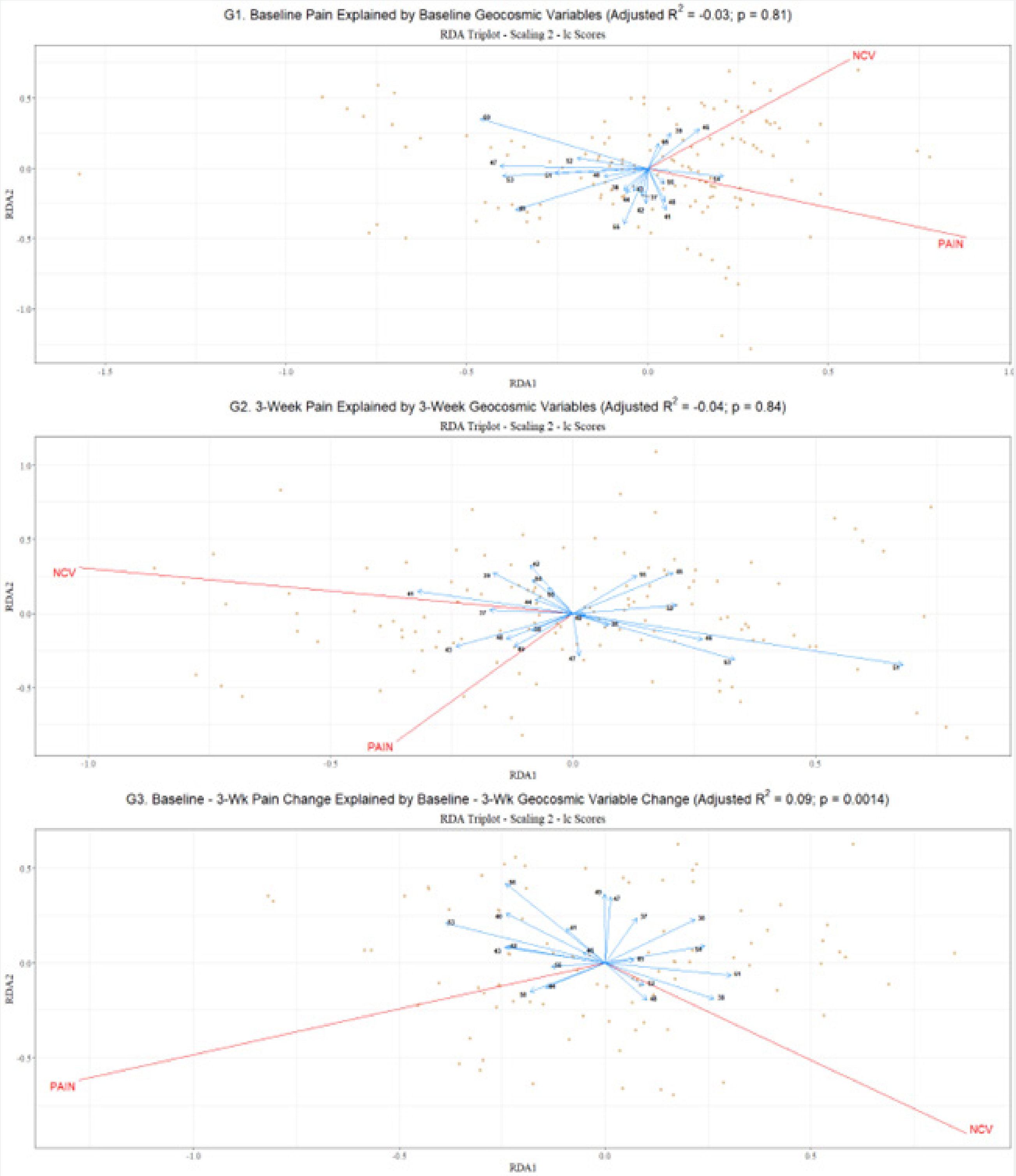

Figure 3: Notes: 37 - Lunar Illumination, 38 - Solar Wind Speed, 39 - Interplanetary Magnetic Field, 40 - Solar Wind, 41 - Proton energies at 10 mega-electron-volts, 42 - Proton energies at 30 mega-electron-volts, 43 - Proton energies at 60 mega-electron-volts, 44 - Global Geomagnetic Field - Ap index, 45 - Global Geomagnetic Field, 46 - ProtonFluence1, 47 - Solar Radio Flux, 48 - SunSpot Number, 49 - SunSpot Area, 50 - Local barometric pressure, 51 - Local humidity, 52 - Local wind, 53 - Local rain, 54 - Local maximum temperature, 55 - Local minimum temperature, 56 - Time of day for visit.

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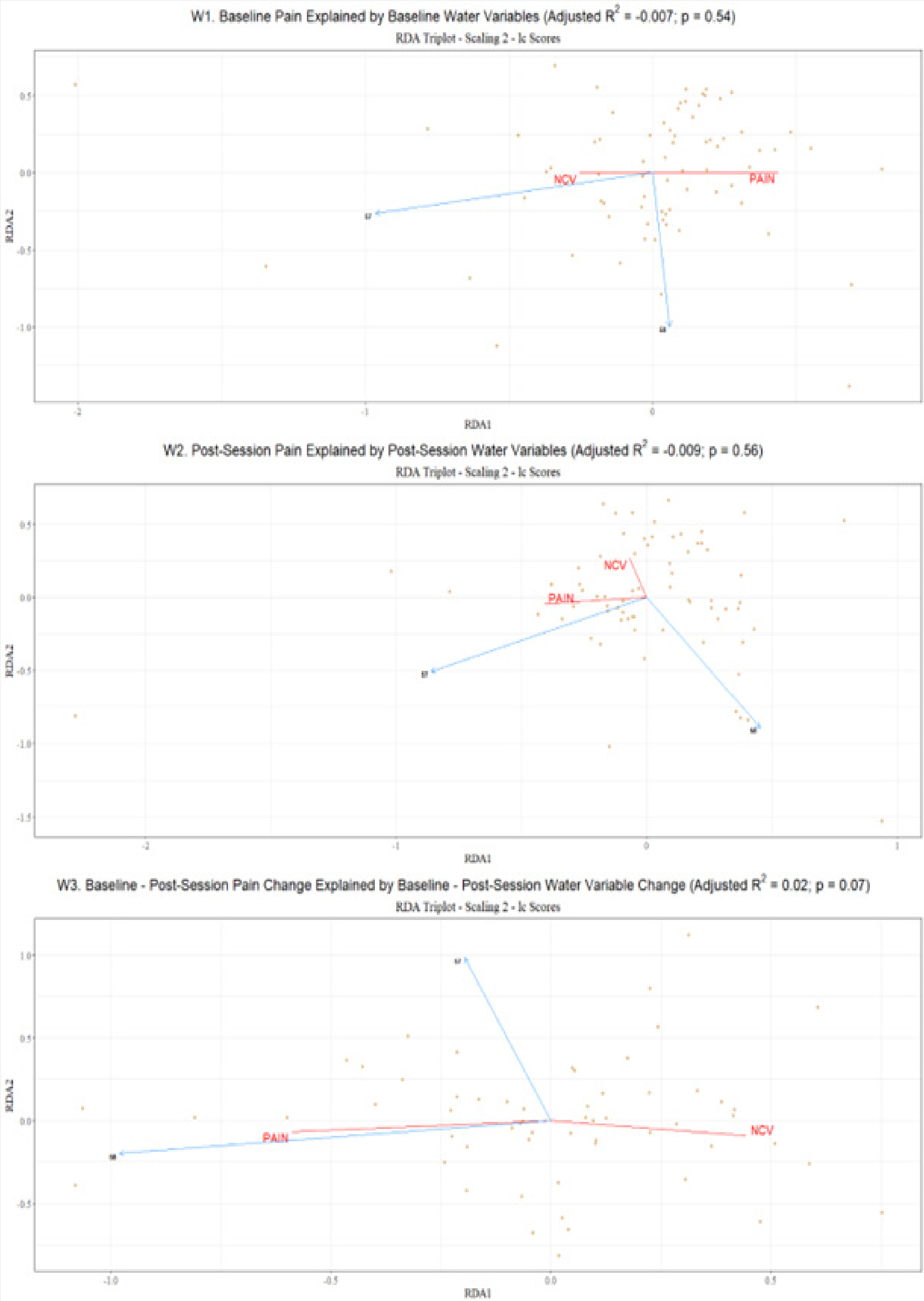

Figure 4: Notes: 57 - Infrared absorbance of participant of distilled water, 58 - Infrared absorbance of practitioner of distilled water.

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Discussion

These exploratory analyses evaluated the relationships between subjective pain symptoms and NCV in the context of energy medicine sessions. Multiple significant relationships were found. Slower NCV was associated with practitioner gender being male and lower participant age. Improved pain was associated with income being $75k to under $150K and the personality trait of openness. Subjective variables, electrocardiography (ECG) measures, geocosmic, and water variables explained 9% (geocosmic) to 29% (subjective/demographic) of the baseline, post-session, and baseline-post-session change in pain and NCV scores. All variables explained 9% of the baseline-post-session pain and NCV scores and 54% of the variation in the baseline to 3-week pain and NCV scores. Multiple positive and negative significant correlations between variables with each other and with pain and NCV were found.

Subjective Potential Predictors

Practitioner gender and age were significant predictors in the NCV model evaluating subjective demographics as predictors. There were six male and eleven female energy medicine practitioners, with male practitioners being associated with a -0.08 decrease in log NCV. This means that having a male practitioner resulted in slower nerve conduction in the participant, and having a female practitioner results in faster nerve conduction. That being said, there was no significant change in the NCV over all three visits for all participants. There was also no significant difference between participant gender in their changes in this measure. Perhaps this difference between practitioner gender resulted from variations in the rapport between the practitioner and participant. Further research would examine practitioner gender in relationship with the rapport of the participant with the practitioner.

Age was also a significant demographic measure in the nerve conduction model. For a one-unit increase in age, a -0.003 decrease in log NCV, meaning that younger participants had faster NCV, which is not surprising considering that NCV decreases with age [37].

Pain score changes were also associated with several subjective predictors. The participant gender being male was associated with a 0.98 increase in subjective pain score. Female participants experienced greater improvements in their pain. Females are at greater risk for many clinical pain conditions and pain sensitivity is greater in females than males, although it is less clear if there are gender differences in response to pain treatment ([38]. There were significantly more female than male participants in the study, which may have influenced these results. Future randomized controlled studies with gender-balanced groups will support the elucidation of this finding.

Interestingly, if the practitioner used touch as part of their methods, a 0.67 increase in their pain score would be expected according to the statistical model. While one might intuitively anticipate that touch would be associated with improvements in pain from a social and emotional perspective, in this case, touch was associated with higher pain ratings. Reviews examining the benefits of healing touch on pain have outlined mixed results [39]. Likely there is greater nuance in the relationship between pain and touch that was not captured in this study.

The expectation from the statistical model is that participants who noted “fair” general health before their session would have a 1.82 increase in their pain scores. Because this is a subjective rating, whether the participant truly has poorer health than those rating themselves as good or excellent health is uncertain. Pain is widespread in people with comorbid chronic conditions and could perhaps influence their pain improvement capacity regardless of the mechanism [40].

Income was a significant demographic predictor. Conditions of economic hardship and daily financial worry ratings are known to negatively influence daily pain ratings [41]. Interestingly, our findings show that the middle-income level ($75k to under $150K) actually had improved pain scores compared to the higher level ($150K or greater), at fixed levels of the remaining explanatory variables.

The personality trait of openness was a significant subjective predictor associated with decreases in pain scores in the presence of the other covariates. Higher harm avoidance and lower self-directedness were the most prominent personality features in chronic pain sufferers noted in an extensive review of 120 years of personality and pain research [41]. A higher personality trait of openness may help people be more willing to be less avoidant and more self-directed in their relationship to their pain. Increased openness has also been noted as a predictor for improved outcomes in a wide variety of studies such as ketamine infusions for depression [42,43], self-transcendence [44], binge eating in obesity [45], to name a few.

What is also striking about the potential predictor models are the variables that were not significant. For example, credibility and expectancy about the intervention, noetic belief and experience, and other demographic variables like education, relationship status, and race were not significantly associated with nerve conduction or pain symptom scores in the presence of the other variables in the models. Perhaps because the model controlled for openness, it does not matter whether the participants thought the intervention was credible or expected it to work. While openness may allude to increased credibility and expectancy, they are not directly related. Credibility and expectancy are noted to have a strong connection to placebo effects [46]. In our study, the participants’ opinion of whether the intervention would or not work for them did not influence the NCV or pain results in the presence of other variables.

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Figure 5

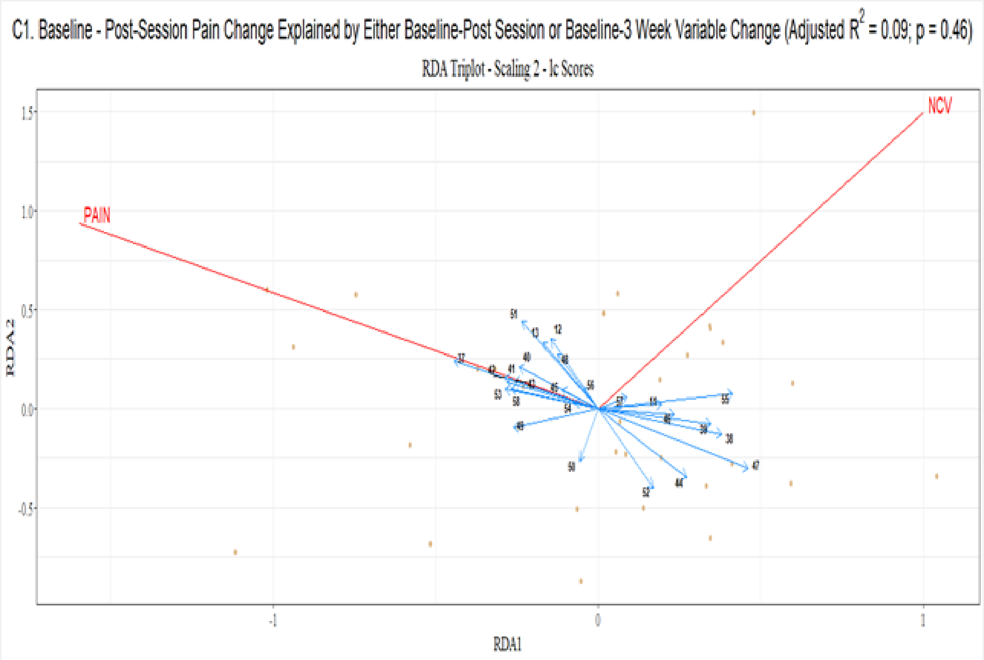

Figure 6

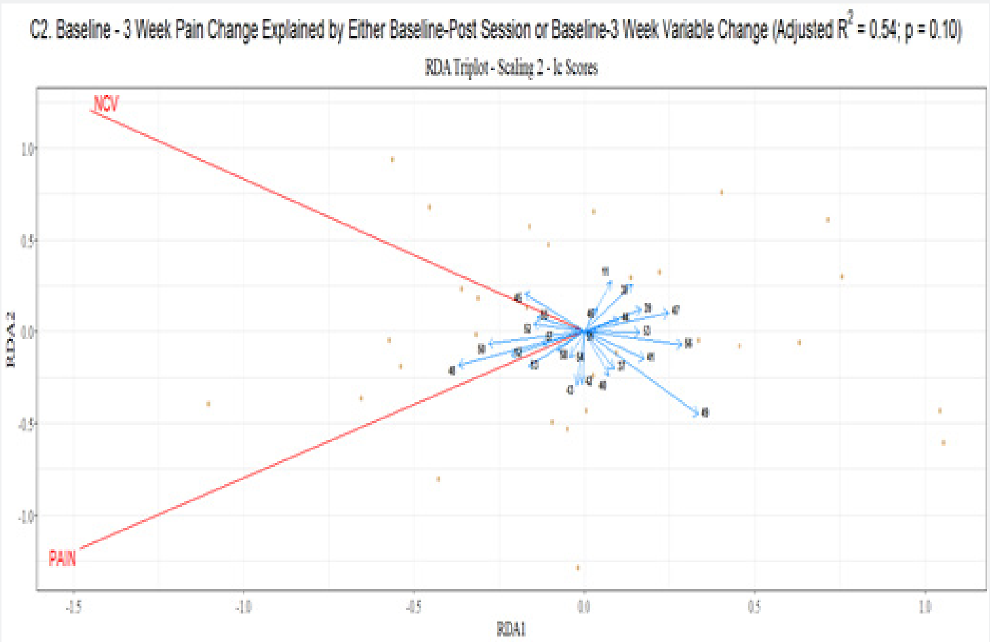

Figure 5 & 6: Notes: 11 - PNS index - Parasympathetic nervous system activity compared to normal resting values, 12 - SNS index - Sympathetic nervous system activity compared to normal resting values, 13 - Stress index, , 24 - SD1 [ms] In Poincaré plot, the standard deviation perpendicular to the line-of-identity, 25 - SD2 [ms] In Poincaré plot, the standard deviation along the line-of-identity, 37 - Lunar Illumination, 38 - Solar Wind Speed, 39 - Interplanetary Magnetic Field, 40 - Solar Wind, 41 - Proton energies at 10 mega-electron-volts, 42 - Proton energies at 30 mega-electron-volts, 43 - Proton energies at 60 mega-electron-volts, 44 - Global Geomagnetic Field - Ap index, 45 - Global Geomagnetic Field, 46 - ProtonFluence1, 47 - Solar Radio Flux, 48 - SunSpot Number, 49 - SunSpot Area, 50 - Local barometric pressure, 51 - Local humidity, 52 - Local wind, 53 - Local rain, 54 - Local maximum temperature, 55 - Local minimum temperature, 56 - Time of day for visit, 57 - Infrared absorbance of participant of distilled water, 58 - Infrared absorbance of practitioner of distilled water.

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RDA

The subjective variables explained 21% of the variation, and the geocosmic variables explained 9% of the change in pain score from baseline to three-week follow-up, leaving 70% of the variation unaccounted for when looking at the variable types separately. The ECG and water variables explained 17% and 9% of the baseline to post-session change, respectively, leaving 80% of the variation unaccounted. All the variables included in the baseline to post-session pain and NCV change explained 9% of the variation. The highest variation for the baseline to 3-week pain and NCV change explained (54%) was in the model with all the variables (Figures 5&6).

Perhaps the RDA analysis's most exciting findings are the supported correlations between the variables and with pain and NCV changes. For example, the ECG data's sympathetic and stress indices were positively correlated with sunspot number, local barometric pressure, and humidity, which were positively correlated with the baseline to post-session and 3-week subjective pain scores for change (i.e., an increase in pain). Similarly, the parasympathetic index was positively correlated with solar wind speed, interplanetary magnetic field, proton fluence, and solar radio flux, which were negatively correlated with the baseline to post-session and 3-week subjective pain scores for change (i.e., a decrease in pain). Other studies have demonstrated relationships between heart rate variability measures and solar and geomagnetic environmental measures [47,48]. As far as we know, this is the first study to evaluate these relationships regarding a clinical intervention for pain.

Conclusion

The results of this study confirm the analyses conducted on outcomes individually [16-19]. They also support the notion that practitioner and participant gender, participant age, income, health status, and the personality trait of openness play some role in energy medicine sessions and pain relief. ECG and geocosmic variables explain variability in pain and NCV change, although the self-report variables were more predictive. Future randomized controlled trials will allow for greater clarity on some of these findings, and additional studies exploring the nuances of some of these relationships are warranted, such as investigating the differences between various styles of energy healing, and the effects of longer and multiple healing sessions.

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Conflicts of Interest

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form. The authors have no conflicts of interest to declare.

The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Reporting Checklist: The authors have completed the MDAR reporting checklist.

Ethics Approval

The trial was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved and overseen by the Institute of Noetic Sciences Institutional Review Board (IORG#0003743) and informed consent was taken from all individual participants.

Author Contributions

Helané Wahbeh- Conception and design, Collection and assumbly of data, Data analysis and interpretation, Manuscript writing, Final approval of manuscript

Maria Wojakowski- Data analysis and interpretation, Manuscript writing, Final approval of manuscript

Garret Yount- Conception and design, Collection and assembly of data, Manuscript writing, Final approval of manuscript

Loren Carpenter- Conception and design, Manuscript writing, Final approval of manuscript

Dean Radin- Conception and design, Manuscript writing, Final approval of manuscript

Arnaud Delorme- Conception and design, Data analysis and interpretation, Manuscript writing, Final approval of manuscript.

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